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(54) **RESTRICTING BROADCAST AND MULTICAST TRAFFIC IN A WIRELESS NETWORK TO A VLAN**

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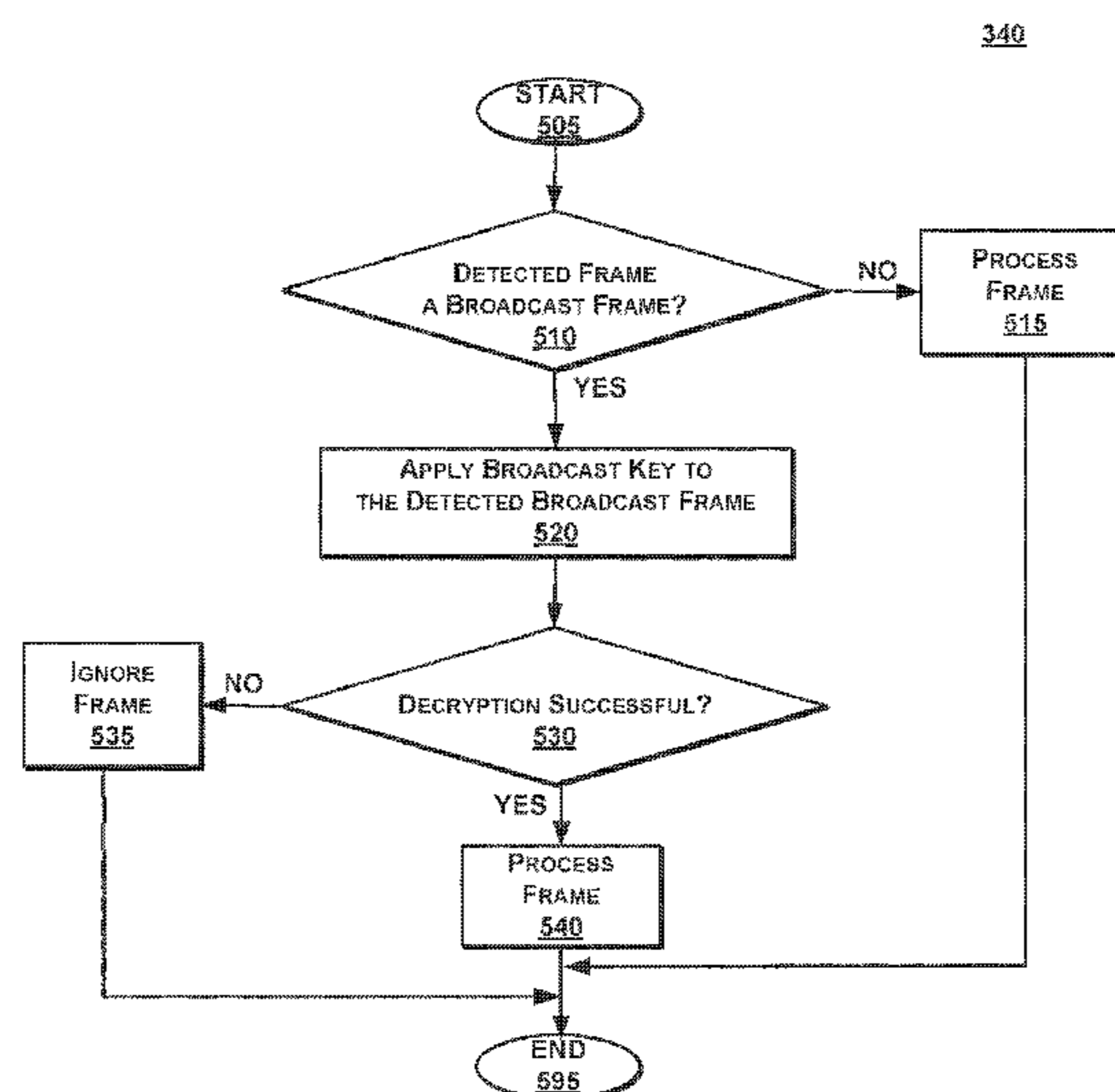
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(57) **ABSTRACT**

Traffic broadcast to a VLAN is restricted. To do so, a plurality of stations are associated with a BSSID (basic service set identifier). A first VLAN is configured by sending a first group key to each station from the plurality of stations that is a member of the first VLAN, wherein each VLAN is associated with a unique group key. One or more frames addressed to the first VLAN are received. The one or more frames are encrypted with the first group key to prevent stations without the first group key from being able to decrypt the one or more frames. The one or more encrypted VLAN frames are broadcast to the plurality of stations associated with the BSSID.

**21 Claims, 7 Drawing Sheets**



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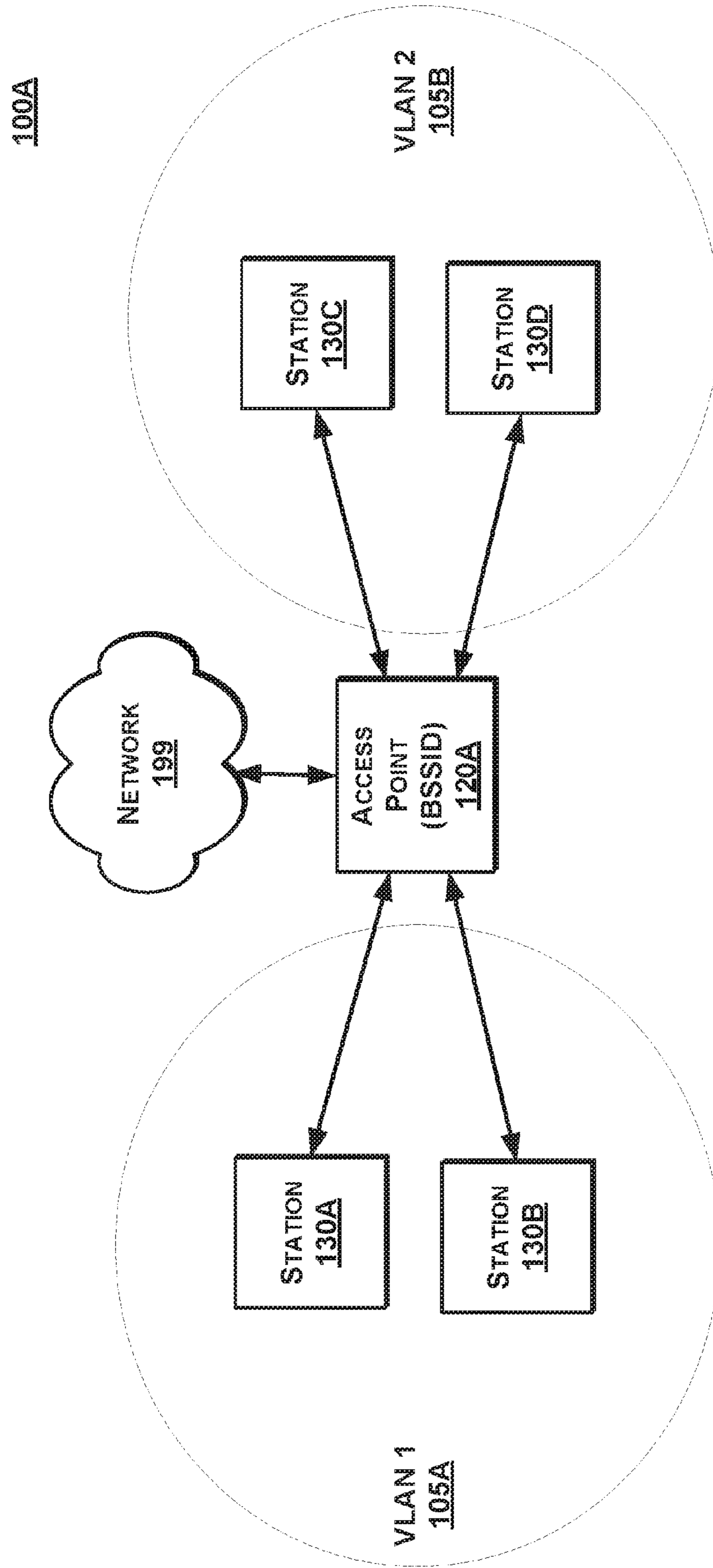


FIG. 1A



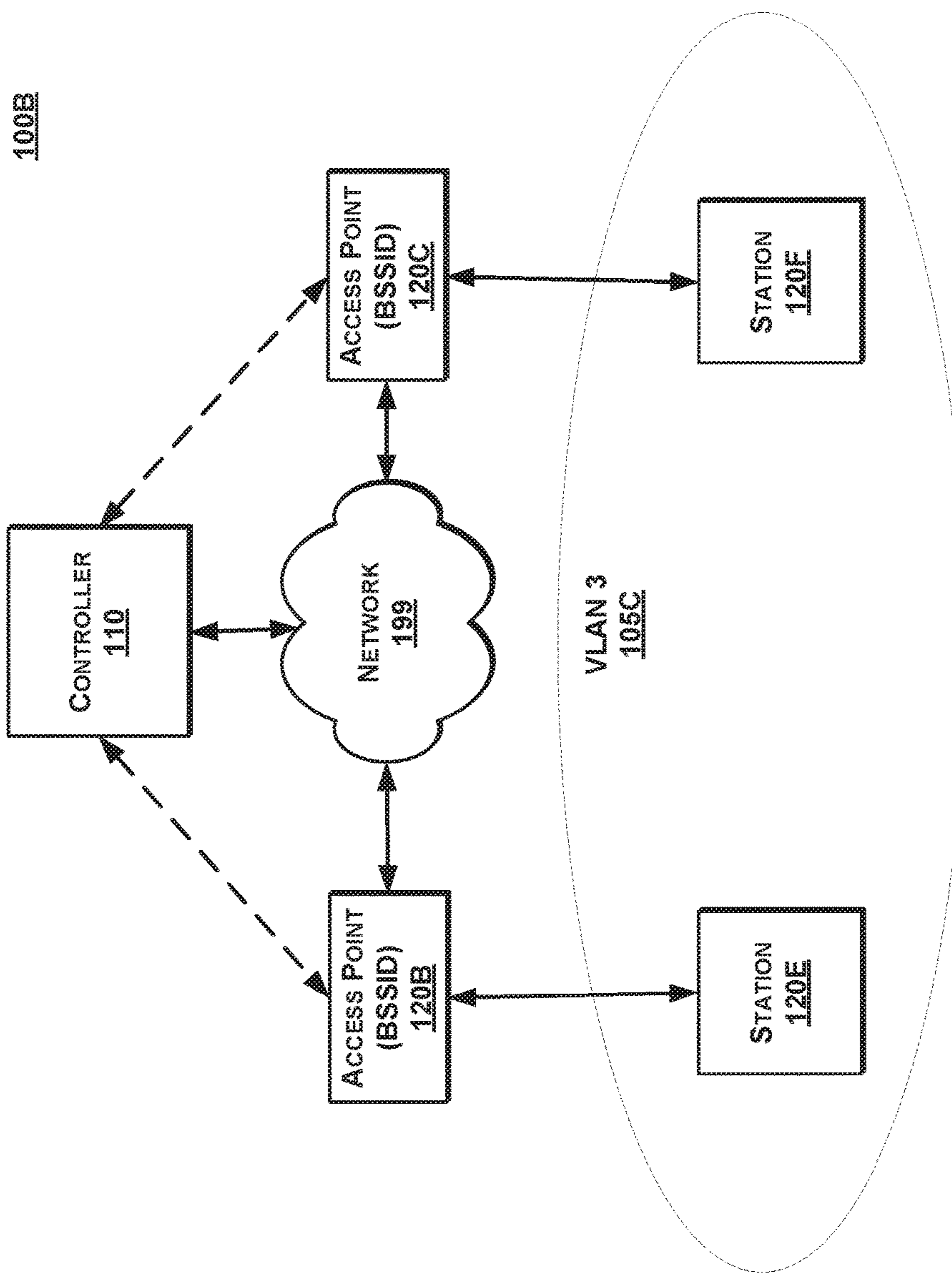


FIG. 1B

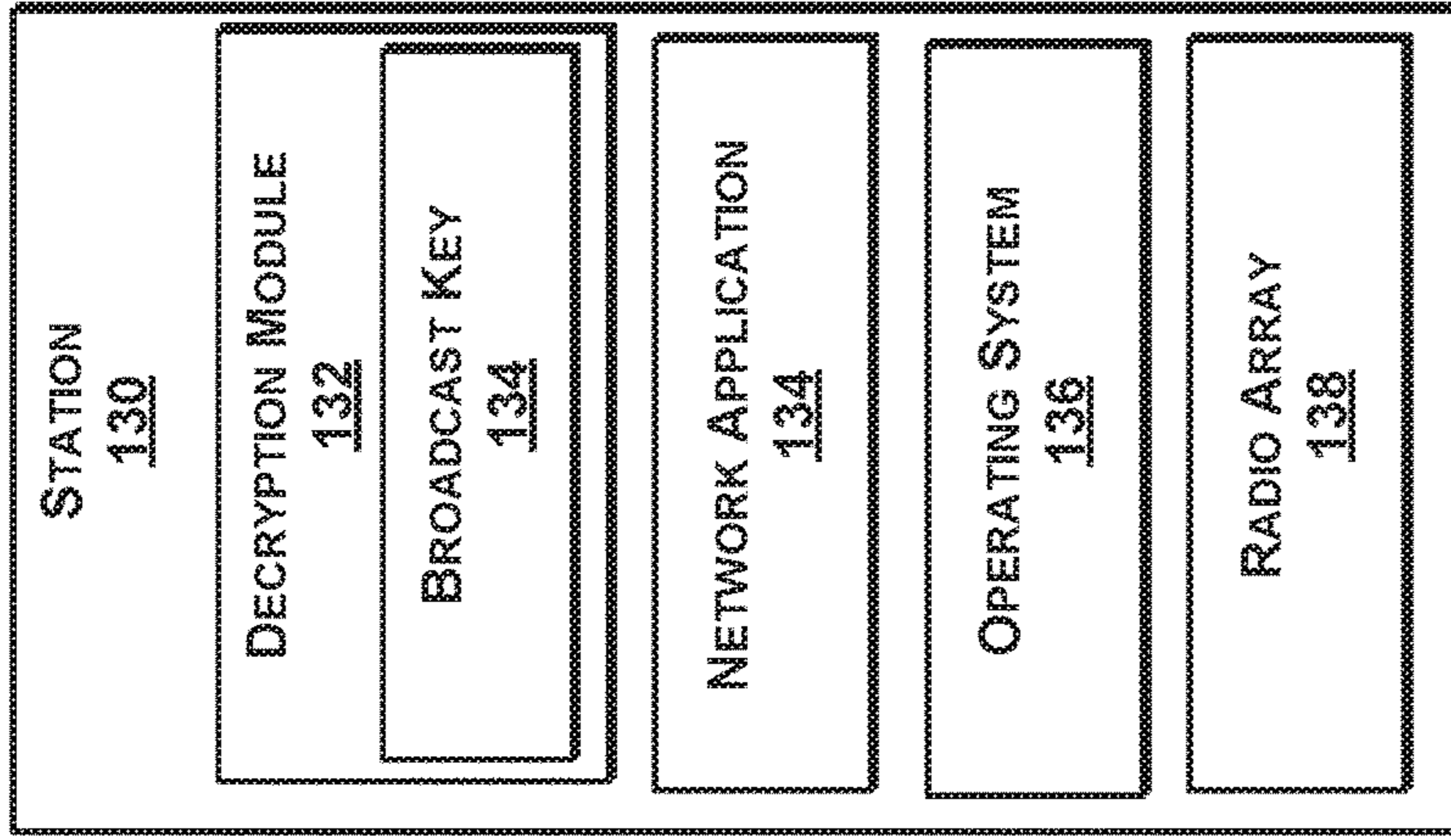


FIG. 2C

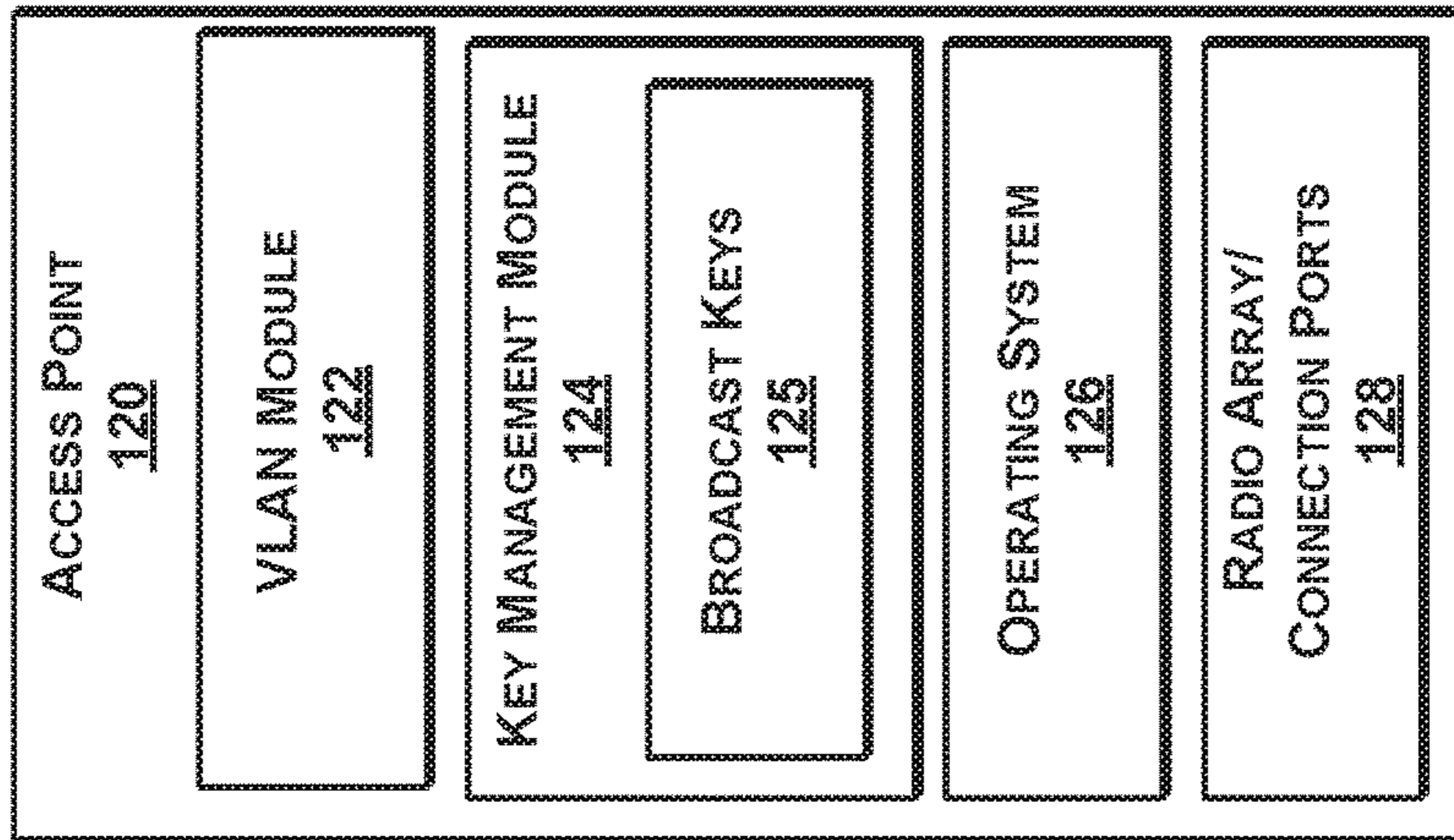


FIG. 2B

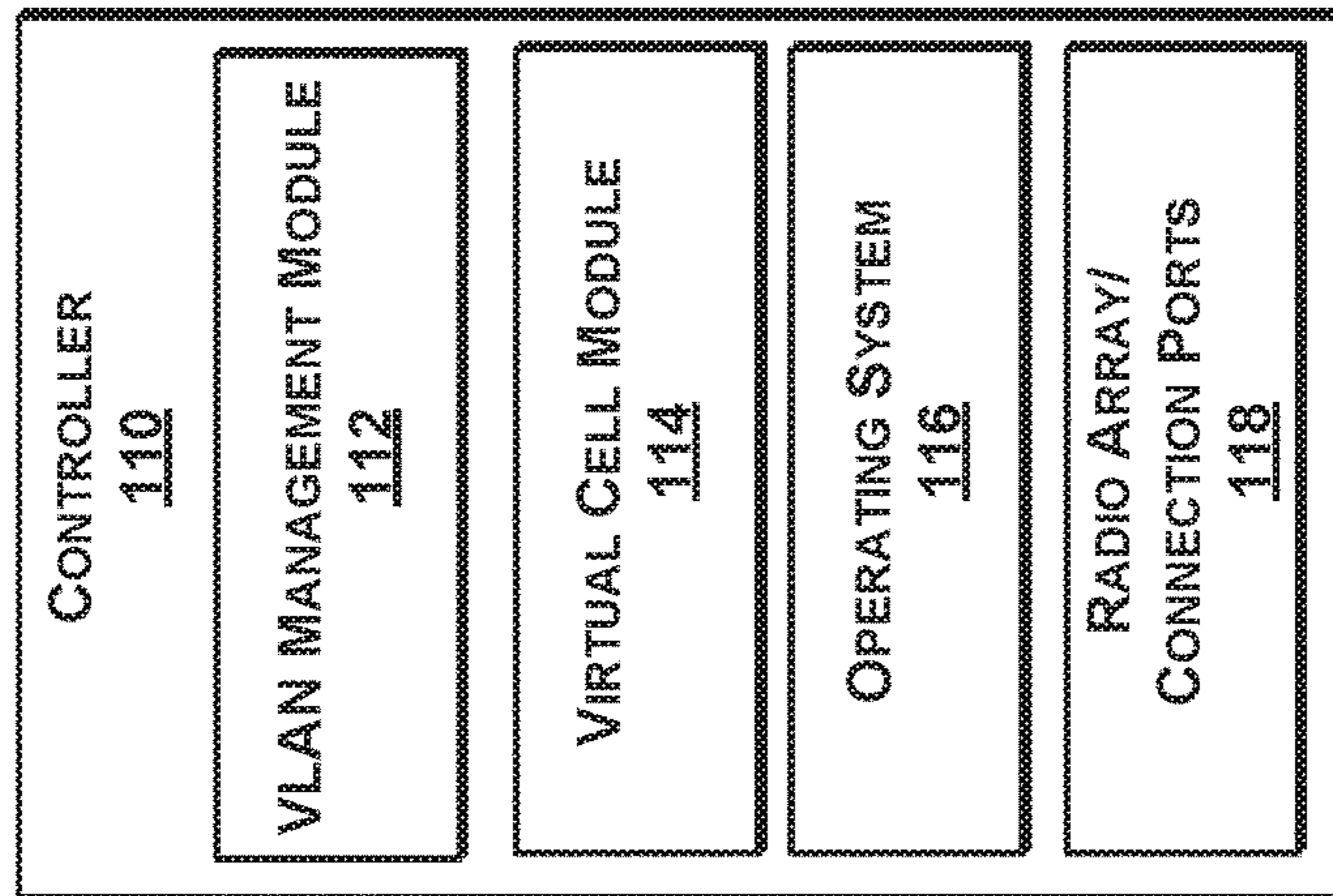
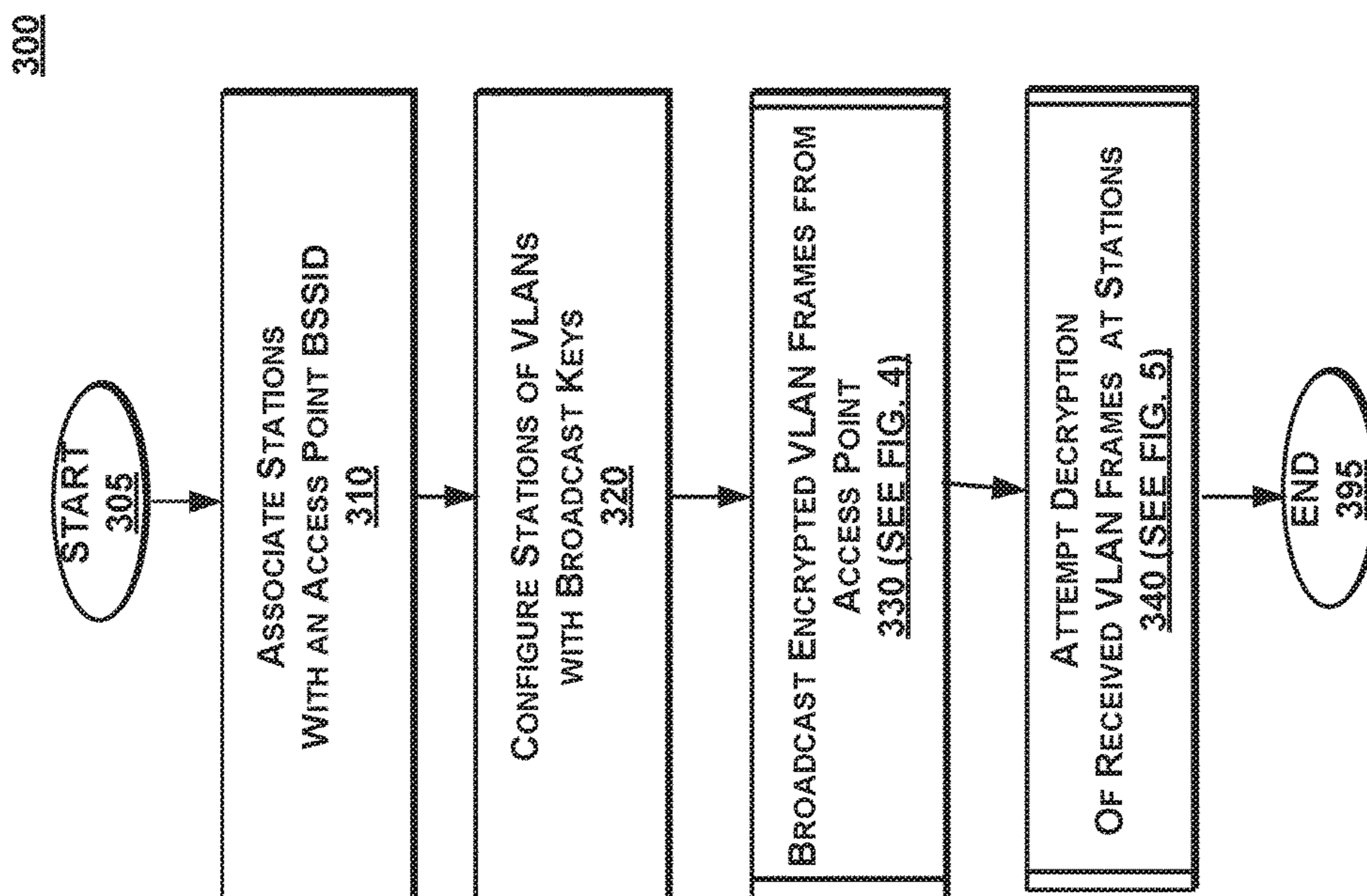


FIG. 2A



**FIG. 3**

330

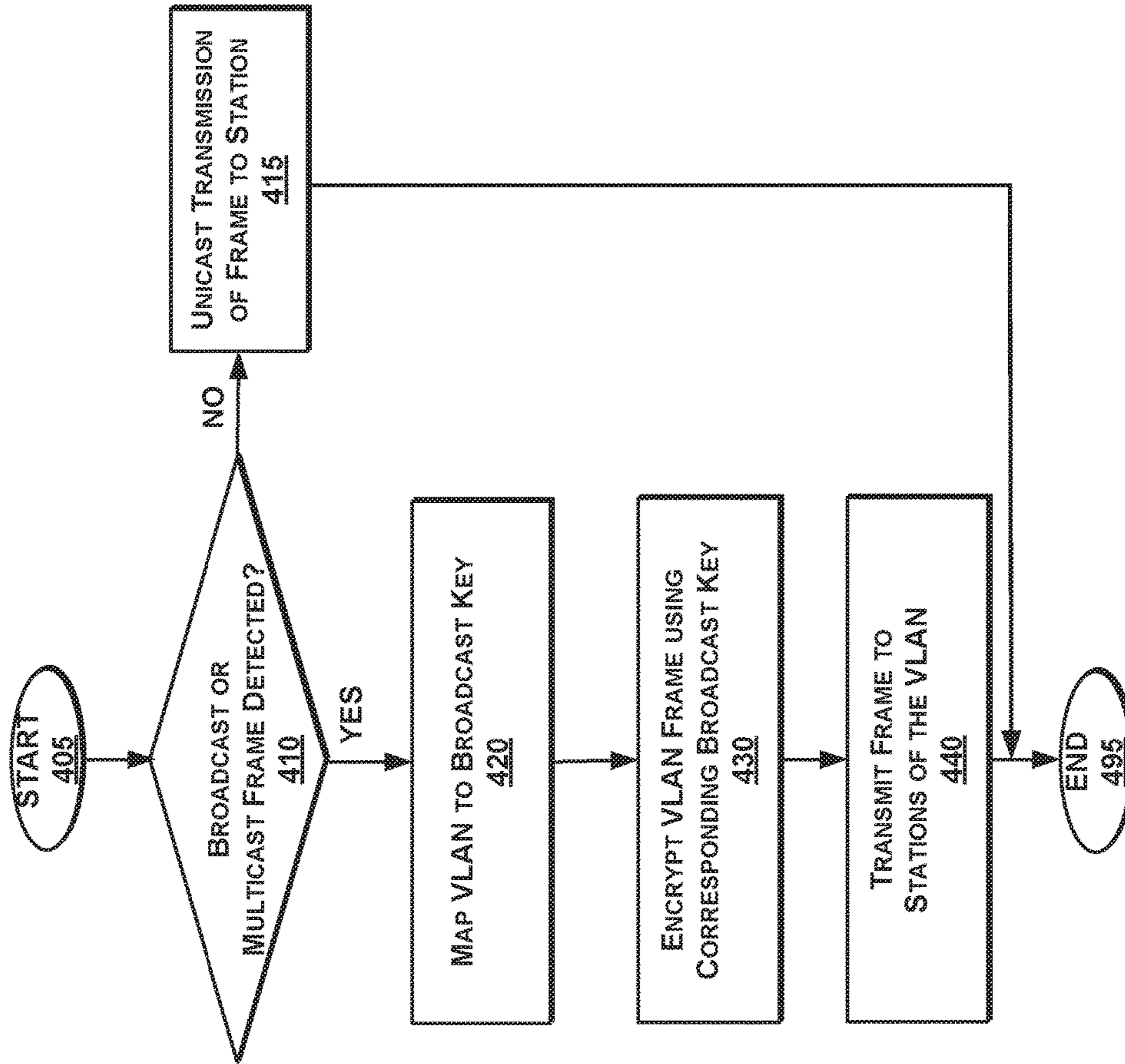


FIG. 4



340

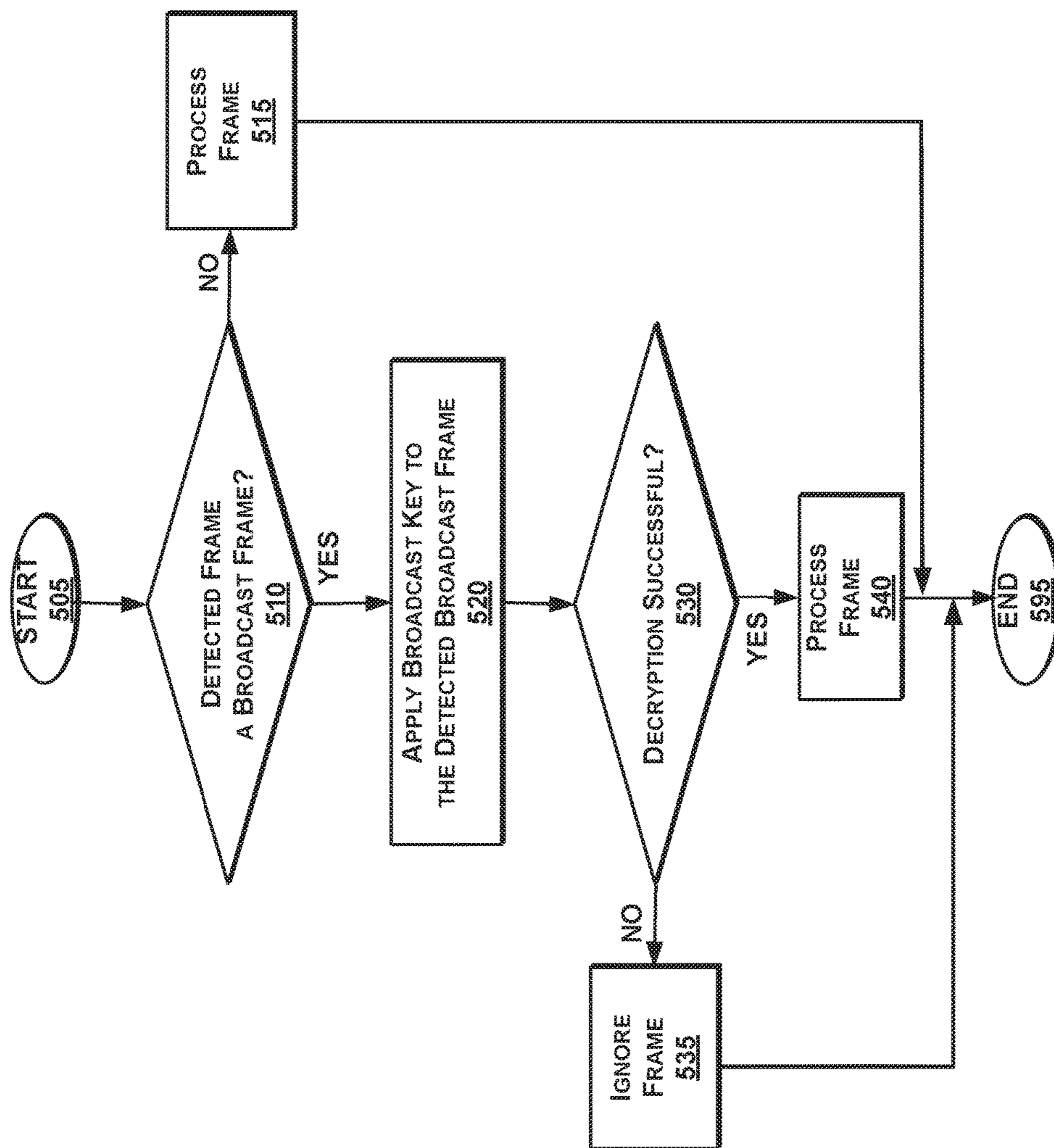


FIG. 5



600

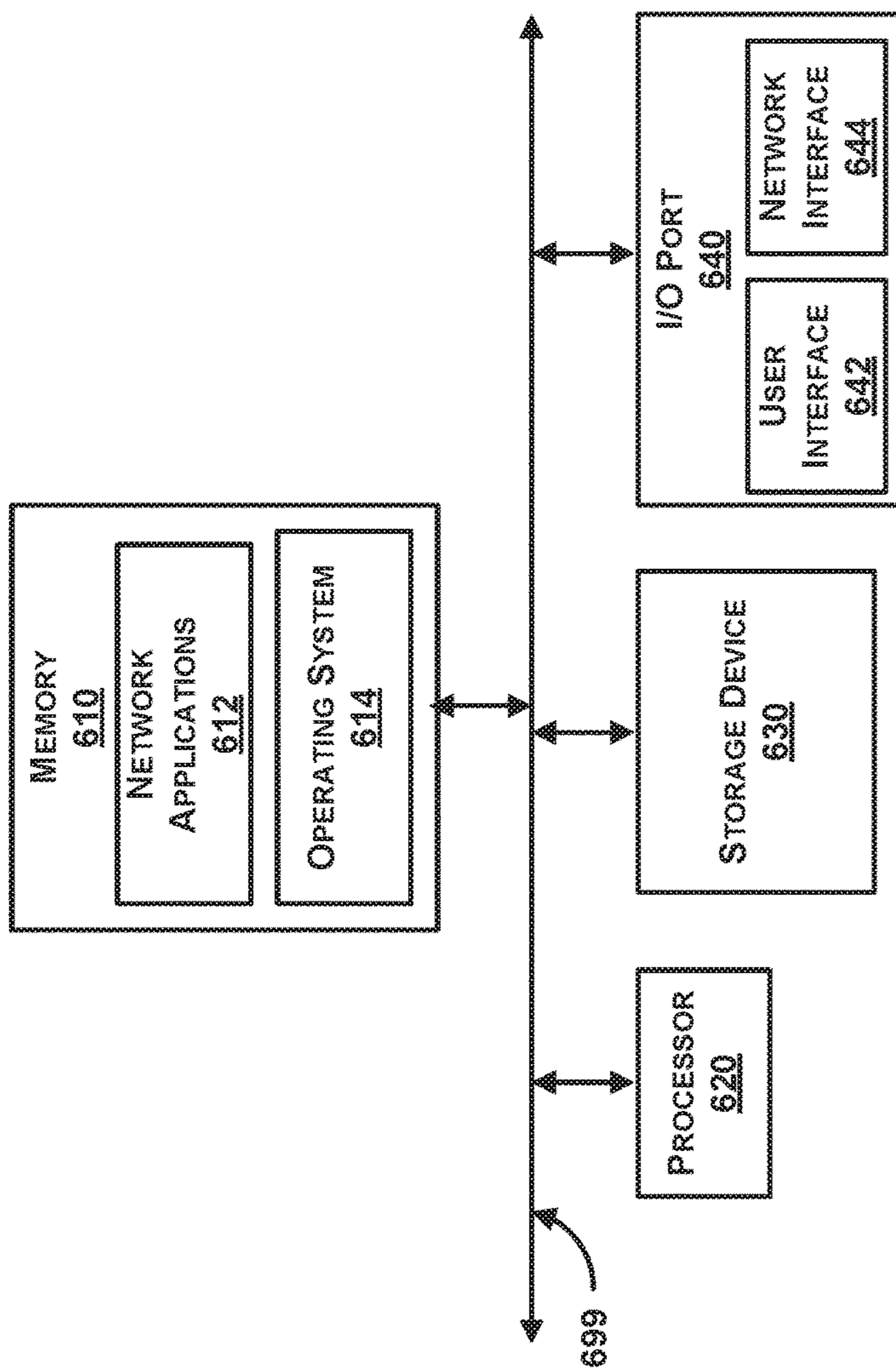


FIG. 6

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## RESTRICTING BROADCAST AND MULTICAST TRAFFIC IN A WIRELESS NETWORK TO A VLAN

### CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 13/772,358, filed Feb. 21, 2013, entitled RESTRICTING BROADCAST AND MULTICAST TRAFFIC IN A WIRELESS NETWORK TO A VLAN, by Mohan Ram, et al., the contents being hereby incorporated by reference in its entirety.

### FIELD OF THE INVENTION

The invention relates generally to computer networking, and more specifically, to restricting broadcast traffic in a wireless network to a VLAN.

### BACKGROUND OF THE INVENTION

Wireless computing technologies provide untethered access to the Internet and other networks. One of the most critical technologies for wireless networking (or Wi-Fi) is the IEEE 802.11 family of protocols promulgated by the Institute of Electrical and Electronics Engineers. Currently, the protocols are widely adopted in wireless devices such as laptop computers, tablet computers, smart phones, and network appliances.

A VLAN (virtual local access network) networks a group of computers together that are not necessarily connected to the same LAN. As a result, one member can broadcast a message to all of the VLAN members using a single packet sent to the Ethernet broadcast or a multicast address rather than sending individual packets to each member. Conventionally, an access point maintains a VLAN table which correlates the Ethernet broadcast or multicast address to particular unicast addresses of each member of that VLAN. It is the access point that sends the frame in a unicast message to each of the members to complete the communication. However, access points typically have low processing capabilities and the burden of multiple address translations for a single message can slow down traffic throughput at the access point.

Another conventional technique dedicates an access point to a particular VLAN. In this way, each of the members share the same BSSID of the access point. Because of the unified membership, the access point can simply broadcast VLAN messages to all connected computers without the additional processing. Problematically, this requires a static association of members to a VLAN which is often not feasible in Enterprise Wireless LAN networks where the members that share same BSSID are dynamically associated to a VLAN based on a user defined policy

What is needed is a robust technique for access points to implement a VLAN that leverages the processing conservation of broadcasting without making the access point unavailable to other stations.

### SUMMARY

To meet the above-described needs, methods, computer program products, and systems for restricting broadcast traffic to a VLAN (virtual local access network) are provided.

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In one embodiment, a plurality of stations with a BSSID (basic service set identifier). A first VLAN is configured by sending a first group key to each station from the plurality of stations that is a member of the first VLAN, wherein each VLAN is associated with a unique group key. One or more frames addressed to the first VLAN are received. The one or more frames are encrypted with the first group key to prevent stations without the first group key from being able to decrypt the one or more frames. The one or more encrypted VLAN frames are broadcast to the plurality of stations associated with the BSSID.

Advantageously, broadcasting is restricted while reducing a processing load on an access point. Further, an access point need not be dedicated to a VLAN. Finally, VLAN members can be retroactively added to a VLAN without a hard handoff.

### BRIEF DESCRIPTION OF THE DRAWINGS

In the following drawings, like reference numbers are used to refer to like elements. Although the following figures depict various examples of the invention, the invention is not limited to the examples depicted in the figures.

FIG. 1A is a high-level block diagram illustrating a system for restricting broadcast traffic to a VLAN (virtual local access network) in a wireless network, according to one embodiment.

FIG. 1B is a high-level block diagram illustrating a system for restricting broadcast traffic to a VLAN in a wireless network with virtual cell, according to one embodiment.

FIG. 2A is a more detailed block diagram illustrating a controller of the system of FIGS. 1A-1B, according to one embodiment.

FIG. 2B is a more detailed block diagram illustrating an access point of the system of FIG. 1B, according to one embodiment.

FIG. 2C is a more detailed block diagram illustrating a station of the system of FIGS. 1A-1B, according to one embodiment.

FIG. 3 is a high-level flow diagram illustrating a method for restricting broadcast traffic to a VLAN in a wireless network, according to one embodiment.

FIG. 4 is a more detailed flow diagram illustrating a step of broadcasting encrypted VLAN frames in the method of FIG. 3, according to one embodiment.

FIG. 5 is a more detailed flow diagram illustrating a step of attempting decrypting VLAN frames in the method of FIG. 3, according to one embodiment.

FIG. 6 is a block diagram illustrating an exemplary computing device, according to one embodiment.

### DETAILED DESCRIPTION

Methods, computer program products, and systems for restricting broadcast traffic for a VLAN (virtual local access network) on a wireless network are disclosed. The following description is set forth merely for the purpose of illustration and is not intended to be limiting. For example, the preferred embodiments refer to broadcast traffic, but are similarly applicable to multicast traffic.

Systems to Restrict Broadcast Traffic to a VLAN (FIGS. 1-2)

FIG. 1A is a high-level block diagram illustrating a system 100 for restricting broadcast traffic for a VLAN on a wireless network, according to one embodiment. The system 100A includes an access point 120 which is in turn



coupled to stations **130A-D** and also coupled to a network **199**. Other embodiments of the system **100** can include additional network components that are not shown in FIG. **1A** (e.g., see FIG. **1B**). For example, there can be more access points, more mobile stations. There can also be switches, routers, fire walls, proxy servers, and the like. The network **199** is preferably a wireless network operating under IEEE 802.11-type protocols, but can also be a hybrid network including some wired components.

The access point **120** can be any suitable computing device, such as a personal computer, a server blade, any computing environment as shown in FIG. **6**. For example, the access point **120** can be an AP 110 or AP 433 by Meru Networks of Sunnyvale, Calif. (modified as discussed herein). Access point **120** is preferably connected to the network **199** (or to a switch, router, hub, or another access point that is connected to the network **199**) via a wired or wireless connection. In one embodiment, the functionality is incorporated into a switch or router. In operation, the access point **120** provides access to a wired network for wireless devices such as stations **130A-D**. A BSSID (basic service set identifier) assigned to the access point **120** distinguishes the access point from other devices that receive transmissions from a station. The BSSID is broadcast in beacon frames at regular intervals for use by stations requesting to connect to the access point **120** for network connectivity.

In one embodiment, the access point **120** implements a VLAN in the network **199** by restricting broadcast traffic. A dedicated address for a VLAN (e.g., an Ethernet broadcast or a multicast address) allows network components to communicate with all members of the VLAN by sending a single frame to a network address set up at the access point **120**. Once the VLAN is configured, a group key is distributed to members of a VLAN for decrypting broadcast and multicast frames sent from the access point **120**. For example, a first group key is sent to members of a first VLAN and a second group key is sent to members of a second VLAN. When frames addressed to any VLAN are received, the access point **120** uses a corresponding group key for encryption before broadcasting to connected stations. However, only stations also having the corresponding group key are able to properly decrypt the encrypted frames. Consequentially, broadcast packets are restricted to a particular VLAN by the access point **120**. Additional embodiments of the access point **120A-120N** are set forth below in FIG. **1C**.

VLAN **1 105A** includes stations **130A** and **130B** and VLAN **2 105B** includes stations **130C** and **130D**. These VLANs can correspond to, for example, different meeting rooms in a building, different product teams of an entity, different levels of employee security, and the like. VLANs can be formed prior to any members connecting to the access point **120A**, or retroactively after members are already connected.

The stations **130A-130D** can be, for example, a personal computer, laptop computer, tablet computer, smart phone, mobile computing device, Internet appliance, end station or any other computing device as described in FIG. **6**. Stations **130A-130D** are wirelessly coupled to the access point **120**. No pre-configuration or downloaded client is needed in a preferred embodiment operating under standard protocols, but can be used to provide enhanced features in other embodiments. The stations **130A-130D** operate according to wireless standards such as IEEE 802.11a, b, g, n, ac or any other wireless standard. The stations **130A-130D** send and/or receive network packets as data for applications running on the devices.

In one embodiment, the stations **130A-130D** listen to all traffic sent from the access point **120**. For encrypted broadcast and multicast traffic, a locally stored, group key is applied in an attempt to decrypt. Successfully decrypted frames are processed by a station while frames that are unable to be decrypted are ignored. In some embodiments, the decrypted frames are passed to a device networked to the particular station, such as in a mesh network. In some embodiments, the stations **130A-130D** set up a group key using IEEE 802.11i or 802.1X as described herein. Additional embodiments of the stations **130A-130D** are discussed in more detail below in association with FIG. **1D**.

FIG. **1B** is a high-level block diagram illustrating a system **100B** for restricting broadcast traffic for a VLAN on a wireless network with virtual cell, according to one embodiment. The system **100** includes a controller **110** and access points **110A-110B** which are in turn coupled to stations **130E-130F** and also coupled to the network **199**. Other embodiments of the system **100B** can include additional network components that are not shown in FIG. **1B**. In one example, there can be additional access points, and in another example there is no controller **110**.

The controller **110** (e.g., an MC1500 or MC6000 device by Meru Networks of Sunnyvale, Calif.) in the network architecture is in communication with each of multiple access points **110A-110B**. The controller **110** can be any of the computing devices discussed above or any other computing device as described in FIG. **6**. The functionality can be incorporated into other devices in communication with the access points **110A-110B**.

In one embodiment, the controller **110** provides a virtual cell service mode to a station within a domain by making the same BSSID available as the station travels around the wireless network. Each of the individual access points **110A-110B** provide a limited range of coverage, and when coordinated, provide a greater range of coverage using a single BSSID without disruption to a station. For example, as station **130E** moves out of range of the access point **120A** and is sensed within the range of the access point **120B**, the controller **110** directs a soft handoff. In response, the access point **120B** takes over communications while the access point **120N** ignores frames addressed from the station **130E**. This soft handoff can be invisible to the station **130E** in that there is no need for local reconfiguration. The soft handoff repeats as a user continues to move amongst different coverage ranges, without interruption of service. In other words, the BSSID is persistent across different access points.

VLAN **3 105C** includes the stations **130E** and **130F**. Due to the virtual cell service, VLAN frames are received by both access points **110A** and **110B** for redistribution. At this point, the access points **110A**, **110B** operate in a similar manner to the access point **120** of FIG. **1** in that a group key encrypts the VLAN frames for restricted broadcasting within the individual coverage areas. Because the stations **130E** and **130F** can be mobile, at different times both may be connected to the same access point as is the case in FIG. **1**.

FIG. **2A** is a more detailed block diagram illustrating the controller **110** of the system **100B** of FIG. **1B**, according to one embodiment. The controller **110** includes a VLAN management module **112**, a virtual cell module **114**, an operating system **116** and a radio array/connection ports **118**. The components can be implemented in hardware, software, or a combination of both.

The VLAN management module **112** can also be implemented (in part or in whole) at the access point level. In one aspect, the VLAN management module **112** provides a user



interface allowing a network administrator to remotely configure VLANs (e.g., membership, authentication credentials, behavior, and the like). In another aspect, the VLAN management module **112** manages access points when operating in virtual cell mode. More particularly, a VLAN frame may be addressed to a particular access point which initially configured the address based on VLAN members connected at that time. The virtual cell services hands off stations to that change coverage areas to a different access point (see FIG. 1B), making the VLAN address stale in relation to handed off stations. The VLAN management module **112** is able to determine which access points need a copy of the VLAN frame in order to distribute the VLAN frame to all members. In a simplified approach, the VLAN management module **112** can broadcast all detected VLAN frames to all access points which in turn perform restricted broadcasting, so that VLAN frames are broadcasted across the entire coverage area.

The virtual cell module **114** assigns access points for communication with particular stations. Each access point shares a common BSSID so that stations can use the same BSSID at any location in the coverage area. Based on a table of mapping assignments of access points to stations that is maintained by the virtual cell module **114**, only the assigned access point responds. Unassigned access points can ignore frames detected by unassigned stations.

The operating system **116** interfaces between the software and hardware of the controller **110**. The operating system **116** can also include integrated applications. Further, the operating system **116** manages connections to access points around a wireless network that are managed by the controller **110**.

The radio array/connection ports **118** represent physical access to communication channels or mediums. A radio array can include one or more transmit (Tx) and receive (Rx) antennas for communication with the physical layer. Some mobile stations **130** include separate antennae for IEEE 802.11a, IEEE 802.11b, IEEE 802.11n, and IEEE 802.11 ac. Other mobile stations **110** include several antenna dedicated for separate transmit and receive paths using the MIMO functionality of IEEE 802.11ac. Antennae can be tuned for IEEE 802.11 transmissions. An Ethernet port can allow plug-in connections to a wired medium using a RJ-45 jack, or the like.

FIG. 2B is a more detailed block diagram illustrating the access point **120** (generic reference to access points **120**, **120A** and **120B**) of the systems **100A** and **100B** of FIGS. 1A and 1B, according to one embodiment. The access point **120** comprises a VLAN module **122**, a key management module **124**, an operating system **126**, and a radio array/connection ports **128**. The components can be implemented in hardware, software, or a combination of both.

The VLAN module **122** configures VLAN membership. When a new VLAN is formed, or when a new member is connected, the VLAN module distributes group key(s). In one embodiment, the VLAN module **122** transmits a group key in response to a connection request (e.g., in accordance with IEEE 802.11i standards). In another embodiment, the VLAN module **122** causes transmission of the group key during authentication. In the case of IEEE 802.1X, a RADIUS server authenticates a station, and provides a group key afterwards. The RADIUS server can be incorporated into the VLAN module **122**, or decoupled as a separate device.

The key management module **124** generates and stores group keys **125**. In some embodiments, keys are generated on-the-fly when a VLAN is configured. In other embodi-

ments, keys are received from external sources such as the controller **110** or a server such as RADIUS server. When a VLAN is deleted, the associated group key can be removed from the group keys **125**. In an embodiment, the access point **120** generates group keys comprising, for example, a 128 bit AES (Advanced Encryption Standard) or a WEP (Wired Equivalent Privacy) cipher. In some embodiments, the access point **120** set up group keys using IEEE 802.11i or 802.1X as described herein.

The operating system **124** interfaces between the software and hardware of the access point **120**. The operating system **124** can also include integrated applications. The operating system **124** can handle connections to stations by sending out beacons.

The radio array/connection ports **126** represent physical access to communication channels or mediums similar to the radio array/connection ports **116** discussed above.

FIG. 2C is a more detailed block diagram illustrating a station **130** (generic reference to stations **130A-130F**) of the systems **100A** and **100B** of FIGS. 1A and 1B, according to one embodiment. The station **130** comprises a decryption module **132**, a network application **134**, an operating system **136**, and a radio array **138**. The components can be implemented in hardware, software, or a combination of both.

The decryption module **132** applies a group key **133** to encrypted broadcast frames. Frames that are decrypted successfully can be processed by the operating system **136** and used by the network application **134**. The decryption module **132** drops frames that are not decrypted successfully are dropped, as these frames were likely intended for a different VLAN. In some embodiments, the decryption module **132** also decrypts non-VLAN encrypted frames.

The network application **132** can be any application executing on the mobile station **130** that makes use of network access in operation. Examples of the network application **132** include a network browser, a VOIP telephone service, a streaming video player, a database viewer, a VPN client, and the like.

The operating system **134** is responsible for connecting to a communication channel for data exchange, among other tasks. To do so, the operating system **134** listens for beacons broadcast by access points, and generates a probe request to connect to a selected access point. After connecting, the operating system **134** exchanges data packs and unpacks data packets in accordance with, e.g., a TCP/IP stack. More particularly, IEEE 802.11-type packets (e.g., IEEE 802.11ac packets) can be generated and received. In some embodiments, the operating system **134** comprises Windows 7, or the like, which integrates support for standards such as IEEE 802.11i and/or IEEE 802.1X.

The radio array **136** includes one or more transmit (Tx) and receive (Rx) antennas for communication with the physical layer, as described above in association with radio array/connection ports **116** and **126**.

Methods for Restricting Broadcast Traffic to a VLAN (FIGS. 3-5)

FIG. 3 is a high-level flow diagram illustrating a method **300** for restricting broadcast traffic to a VLAN in a wireless network, according to one embodiment. The method **300** can be implemented by, for example, the systems **100A** and **100B** of FIG. 1A and FIG. 1B, accordingly.

At step **310**, stations are associated with an access point BSSID. In one implementation, an access point openly broadcast a BSSID in beacons are regular intervals. An unconnected station receives beacons from one or more access points and chooses (e.g., as directed by a user) a particular access point for connection. The station responds



to the access point with a connection request. The BSSID can be different for each access point, or shared between multiple access points to effect virtual cell service as described above.

At step **320**, stations of VLANs are configured with group keys. If the connecting station has been preconfigured to join a particular VLAN, the access point embeds a corresponding group key in the response to the connection request. In one embodiment, the key is sent in accordance with standards such as IEEE 802.11i and/or IEEE 802.1X.

At step **330**, encrypted VLAN frames from access point are broadcast. Additional embodiments are set forth below with respect to FIG. 4.

At step **340**, decryption of received VLAN frames is attempted at stations. All stations receiving the broadcast, especially those associated with the BSSID can attempt to process the broadcast frames. More details of step **340** are described below with respect to FIG. 5.

FIG. 4 is a more detailed flow diagram illustrating a step of broadcasting encrypted VLAN frames in the method of FIG. 3, according to one embodiment.

At step **410**, if a broadcast or a multicast frame is detected, a VLAN is mapped to a group key at step **420**. VLAN frames can be indicated by a destination address, such as an IP address or a specific port number of an IP address. When the VLAN is configured, the access point (or other network device) generates and stores a mapping between an assigned address and addresses of VLAN members. As a result, frames can be sent to all of the VLAN members using a single address.

If frames are not for a VLAN, normal unicast processing can occur at step **415**. Rather than broadcasting to an address recognized by all connected stations, an address of a specific station is used.

At step **430**, a VLAN frame is encrypted to using a group key corresponding to the VLAN. The encryption prevents stations that are able to receive the frames, whether or not addressed to them, from being able to read the contents. Instead, the data is indiscernible.

At step **440**, the frame is transmitted to stations of the VLAN. The transmission can be handled by an operating system in an access point with integrated TCP/IP support. At the physical layer, a uses electromagnetic radio transmitters and receivers. The broadcast can be received by any appropriate radio within coverage range regardless as to whether the radio is part of the VLAN, but is typically ignored if not specifically addressed to a computing device associated with the radio. The restricted broadcasting described herein can prevent radios unassociated with the VLAN from being able to reconstruct broadcast frames.

FIG. 5 is a more detailed flow diagram illustrating a step of attempting decrypting VLAN frames in the method of FIG. 3, according to one embodiment.

At step **510**, if a broadcast frame is detected, a group key is applied at step **520**. The group key decodes the indiscernible data back its original form. At step **530**, if decryption is successful, the frame is processed at step **540**.

On the other hand, if the detected frame is not a broadcast frame at step **510**, the frame can be processed as a unicast frame at step **515**. Implementations are variable, but non broadcast frames can also include a decryption component using the group key or other key. However, if the decryption is unsuccessful during frame processing at step **515**, some implementations may invoke an exception process or error routine rather than simply ignoring the frame.

If the decryption at step **530** is unsuccessful for broadcast frames, the frame is ignored at **535**, the implication being that the frame was intended for a different VLAN.

Generic Computing Device (FIG. 6)

FIG. 6 is a block diagram illustrating an exemplary computing device **600** for use in the system **100** of FIG. 1A, according to one embodiment. The computing device **600** is an exemplary device that is implementable for each of the components of the system **100**, including the access point **120**, and the mobile stations **130A, B**. Additionally, the computing device **600** is merely an example implementation itself, since the system **100** can also be fully or partially implemented with laptop computers, tablet computers, smart cell phones, Internet appliances, and the like.

The computing device **600**, of the present embodiment, includes a memory **610**, a processor **620**, a hard drive **630**, and an I/O port **640**. Each of the components is coupled for electronic communication via a bus **699**. Communication can be digital and/or analog, and use any suitable protocol.

The memory **610** further comprises network applications **612** and an operating system **614**. The network applications **620** can include the modules of network applications or access points as illustrated in FIGS. 6 and 7. Other network applications can include 612 a web browser, a mobile application, an application that uses networking, a remote application executing locally, a network protocol application, a network management application, a network routing application, or the like.

The operating system **614** can be one of the Microsoft Windows® family of operating systems (e.g., Windows 95, 98, Me, Windows NT, Windows 2000, Windows XP, Windows XP x64 Edition, Windows Vista, Windows CE, Windows Mobile), Windows 7, Windows 8, Linux, HP-UX, UNIX, Sun OS, Solaris, Mac OS X, Alpha OS, AIX, IRIX32, or IRIX64. Other operating systems may be used. Microsoft Windows is a trademark of Microsoft Corporation.

The processor **620** can be a network processor (e.g., optimized for IEEE 802.11), a general purpose processor, an application-specific integrated circuit (ASIC), a field programmable gate array (FPGA), a reduced instruction set controller (RISC) processor, an integrated circuit, or the like. Qualcomm Atheros, Broadcom Corporation, and Marvell Semiconductors manufacture processors that are optimized for IEEE 802.11 devices. The processor **620** can be single core, multiple core, or include more than one processing elements. The processor **620** can be disposed on silicon or any other suitable material. The processor **620** can receive and execute instructions and data stored in the memory **610** or the storage device **630**.

The storage device **630** can be any non-volatile type of storage such as a magnetic disc, EEPROM, Flash, or the like. The storage device **630** stores code and data for applications.

The I/O port **640** further comprises a user interface **642** and a network interface **644**. The user interface **642** can output to a display device and receive input from, for example, a keyboard. The network interface **644** connects to a medium such as Ethernet or Wi-Fi for data input and output. In one embodiment, the network interface **644** includes IEEE 802.11 antennae.

Many of the functionalities described herein can be implemented with computer software, computer hardware, or a combination.

Computer software products (e.g., non-transitory computer products storing source code) may be written in any of various suitable programming languages, such as C, C++,



C#, Java, JavaScript, PHP, Python, Perl, Ruby, and AJAX. The computer software product may be an independent application with data input and data display modules. Alternatively, the computer software products may be classes that are instantiated as distributed objects. The computer software products may also be component software such as Java Beans (from Sun Microsystems) or Enterprise Java Beans (EJB from Sun Microsystems).

Furthermore, the computer that is running the previously mentioned computer software may be connected to a network and may interface to other computers using this network. The network may be on an intranet or the Internet, among others. The network may be a wired network (e.g., using copper), telephone network, packet network, an optical network (e.g., using optical fiber), or a wireless network, or any combination of these. For example, data and other information may be passed between the computer and components (or steps) of a system of the invention using a wireless network using a protocol such as Wi-Fi (IEEE standards 802.11, 802.11a, 802.11b, 802.11e, 802.11g, 802.11i, 802.11n, and 802.ac, just to name a few examples). For example, signals from a computer may be transferred, at least in part, wirelessly to components or other computers.

In an embodiment, with a Web browser executing on a computer workstation system, a user accesses a system on the World Wide Web (WWW) through a network such as the Internet. The Web browser is used to download web pages or other content in various formats including HTML, XML, text, PDF, and postscript, and may be used to upload information to other parts of the system. The Web browser may use uniform resource identifiers (URLs) to identify resources on the Web and hypertext transfer protocol (HTTP) in transferring files on the Web.

This description of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form described, and many modifications and variations are possible in light of the teaching above. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications. This description will enable others skilled in the art to best utilize and practice the invention in various embodiments and with various modifications as are suited to a particular use. The scope of the invention is defined by the following claims.

We claim:

1. A computer-implemented method, in an access point of a wireless network, for restricting broadcast traffic to a VLAN (virtual local area network), the method comprising the steps of:

associating a plurality of stations with a BSSID (basic service set identifier);

receiving a list of members of a first VLAN;

configuring a first VLAN by sending a first group key to each station from the plurality of stations that is a member of the first VLAN, wherein each VLAN is associated with a unique group key sent to stations of each VLAN using the IEEE 802.1X protocol, and wherein the unique group key decrypts frames sent by the access point for decryption only by the plurality of stations in the specific group and the unique group key also decrypts general, non-VLAN frames sent by the access point for decryption by any of the plurality of stations;

receiving one or more frames addressed to the first VLAN at either a broadcast port or a multicast port of the access point;

determining if the one or more frames is at least one of a broadcast frame and a multicast frame;

in response to a determination that the one or more frames is at least one of a broadcast frame and a multicast frame:

mapping the first group key to the first VLAN, wherein the mapping stores an assigned address between the first VLAN and the corresponding addresses of all first VLAN members;

encrypting the one or more frames with the first group key to prevent stations without the first group key from being able to decrypt the one or more frames, wherein the plurality of stations process successfully decrypted frames and ignore frames that are not successfully decrypted; and

broadcasting the one or more encrypted VLAN frames to the plurality of stations associated with the BSSID; wherein at least one station from the first VLAN is handed-off to a different access point while retaining membership in the first VLAN.

2. The method of claim 1, further comprising:

configuring a second VLAN by sending a second group key to each station that is a member of the second VLAN;

receiving one or more frames addressed to the second VLAN;

encrypting the one or more frames with the second group key to prevent stations without the second group key from being able to decrypt the one or more frames.

3. The method of claim 1, further comprising:

receiving a list of members of the first VLAN.

4. The method of claim 1, wherein the one or more frames are addressed to either a broadcast port or a multicast port of the access point.

5. The method of claim 1, wherein the access point is part of a virtual cell service provided by the wireless network in which the BSSID is also associated with at least one other access points in the wireless network and at least one station from the first VLAN is connected to one of the at least one other access points.

6. The method of claim 1, wherein the first group key is sent to the station using the IEEE 802.1X protocol.

7. The method of claim 1, wherein the first group key also decrypts general, non-VLAN frames sent by the access point to the plurality of stations.

8. The method of claim 1, wherein the members of the first VLAN comprise a subset of stations associated with the BSSID.

9. The method of claim 1, wherein the station processes successfully decrypted frames and ignores frames that are not successfully decrypted.

10. The method of claim 1, wherein the wireless network comprises an IEEE 802.11-type network.

11. A non-transitory computer-readable medium storing instructions that, when executed by a processor, perform a method in an access point of a wireless network, for restricting broadcast traffic to a VLAN (virtual local area network), the method comprising:

associating a plurality of stations with a BSSID (basic service set identifier);

receiving a list of members of a first VLAN;

configuring a first VLAN by sending a first group key to each station from the plurality of stations that is a member of the first VLAN, wherein each VLAN is associated with a unique group key sent to stations of each VLAN using the IEEE 802.1X protocol, and wherein the unique group key decrypts frames sent by



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the access point for decryption only by the plurality of stations in the specific group and the unique group key also decrypts general, non-VLAN frames sent by the access point for decryption by any of the plurality of stations;

receiving one or more frames addressed to the first VLAN at either a broadcast port or a multicast port of the access point;

determining if the one or more frames is at least one of a broadcast frame and a multicast frame;

in response to a determination that the one or more frames is at least one of a broadcast frame and a multicast frame:

mapping the first group key to the first VLAN, wherein the mapping stores an assigned address between the first VLAN and the corresponding addresses of all first VLAN members;

encrypting the one or more frames with the first group key to prevent stations without the first group key from being able to decrypt the one or more frames, wherein the plurality of stations process successfully decrypted frames and ignore frames that are not successfully decrypted; and

broadcasting the one or more encrypted VLAN frames to the plurality of stations associated with the BSSID; wherein at least one station from the first VLAN is handed-off to a different access point while retaining membership in the first VLAN.

12. The computer-readable medium of claim 11, the method further comprising:

configuring a second VLAN by sending a second group key to each station that is a member of the second VLAN;

receiving one or more frames addressed to the second VLAN;

encrypting the one or more frames with the second group key to prevent stations without the second group key from being able to decrypt the one or more frames.

13. The computer-readable medium of claim 11, the method further comprising:

receiving a list of members of the first VLAN.

14. The computer-readable medium of claim 11, wherein the one or more frames are addressed to either a broadcast port or a multicast port of the access point.

15. The computer-readable medium of claim 11, wherein the access point is part of a virtual cell service provided by the wireless network in which the BSSID is also associated with at least one other access points in the wireless network and at least one station from the first VLAN is connected to one of the at least one other access points.

16. The computer-readable medium of claim 11, wherein the first group key is sent to the station using the IEEE 802.1X protocol.

17. The computer-readable medium of claim 11, wherein the first group key also decrypts general, non-VLAN frames sent by the access point to the plurality of stations.

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18. The computer-readable medium of claim 11, wherein the members of the first VLAN comprise a subset of stations associated with the BSSID.

19. The computer-readable medium of claim 11, wherein the station processes successfully decrypted frames and ignores frames that are not successfully decrypted.

20. The computer-readable medium of claim 11, wherein the wireless network comprises an IEEE 802.11-type network.

21. An access point of a wireless network, for restricting broadcast traffic to a VLAN (virtual local area network), the access point comprising:

- a processor;
- a communication interface; and
- a memory, communicatively coupled to the processor and communication interface, and storing:
  - a first module to associate a plurality of stations with a BSSID (basic service set identifier);
  - a second module to receive a list of members of a first VLAN;
  - a third module to configure a first VLAN by sending a first group key to each station from the plurality of stations that is a member of the first VLAN, wherein each VLAN is associated with a unique group key sent to stations of each VLAN using the IEEE 802.1X protocol, and wherein the unique group key decrypts frames sent by the access point for decryption only by the plurality of stations in the specific group and the unique group key also decrypts general, non-VLAN frames sent by the access point for decryption by any of the plurality of stations;
  - a fourth module to receive one or more frames addressed to the first VLAN at either a broadcast port or a multicast port of the access point;
  - a fifth module to determine if the one or more frames is at least one of a broadcast frame and a multicast frame;
  - a sixth module, in response to a determination that the one or more frames is at least one of a broadcast frame and a multicast frame, to map the first group key to the first VLAN, wherein the mapping stores an assigned address between the first VLAN and the corresponding addresses of all first VLAN members;
  - a seventh module to encrypt the one or more frames with the first group key to prevent stations without the first group key from being able to decrypt the one or more frames, wherein the plurality of stations process successfully decrypted frames and ignore frames that are not successfully decrypted; and
  - a eighth module to broadcast the one or more encrypted VLAN frames to the plurality of stations associated with the BSSID,

wherein at least one station from the first VLAN is handed-off to a different access point while retaining membership in the first VLAN.

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